Zn^{69}. Chemical yields were not determined, but on the basis of preliminary tracer experimentation with the columns, and continual monitoring during each separation, sample loss greater than 10 percent is considered improbable.

The analytical results obtained are presented in Tables 1 and 2. The estimated maximum uncertainty of these measurements is 20 percent. On the basis of the data in Table 1, corrections not exceeding 10 percent have been applied to the raw data to give the figures of Table 2.

In view of the limited data presently available, interpretation of these results must be made with great caution. Since some of the results are unexpectedly high, the following suggested sources for the heavy metals found are evaluated briefly.

Natural sources in inclusions: (i) in solution, evaporates to a water-soluble form; (ii) in solution, evaporates to an acid-soluble form; (iii) visible daughter mineral grains, acid-soluble; and (iv) invisible films or dust of daughter minerals, acid-soluble. *Natural sources in host minerals:* (v) solid inclusions of chalcopyrite and sphalerite; (vi) solid inclusions of oxidation products; and (vii) integral part of host mineral structure. *External sources (introduced):* (viii) leaching of stainless steel tubes; (ix) other containers, water, acid, and reagents; and (x) accidental contamination.

The simplest interpretation is that the water leach values represent source (i) and the acid leach values source (ii). On the basis of microscopy, source (iii) is nil for the fluorite sample and probably nil for the quartz sample. Source (iv) would seem to be inadequate, as the required ore mineral film thicknesses ($> 1\ \mu$) or dust concentrations (3 to 6 mg/cm^2) would be visible. For the quartz sample, source (v) is very possible, in view of the microscopy and the occurrence with sphalerite and chalcopyrite. However, leaching experiments on sphalerite and chalcopyrite, from the same vein, indicated rates of solution three or more orders of magnitude too low to explain the results obtained. Analysis of the residue (Table 3) also shows that such mineral grains cannot be present in large amounts. The fluorite sample had no "large" solid inclusions, and many thousands of small ones ($< 10\ \mu$) would have to have dissolved to explain the high Cu and Zn acid leach values. Analysis of the residue (Table 3) and a determination of the maximum rates of solution under the conditions used indicate that less than 1.5 μg of Zn could come from this source, plus source (vii). Source (vi) seems unlikely as a contributor for the quartz sample. It would require both water- and acid-soluble minerals to be enclosed in the quartz, and hence immune to electrolytic cleaning, and yet to be almost completely exposed to the leaching after coarse crushing. Source (vi) is even more unlikely for the fluorite sample, because the amount of zinc and copper found on acid leaching would require the equivalent of a grain of basic sulfate nearly 0.5 mm in diameter for each metal—far more than would remain unobserved. Leaching tests on the stainless tubes indicate that source (viii) contributed less than 10 percent contamination to the acid leaches. The very low values for the blanks (Table 1) indicate that the total contribution from all sources listed under (ix) must be small. Source (x) can never be fully evaluated, except by additional determinations. The unlikely possibility of contamination by brass from the vacuum line was shown to be completely unrealistic by studies of the rates of solution of brass chips. Simultaneous contamination of one sample (the fluorite) with similar amounts of Cu and Zn also seems unlikely.

It may be suggested that minimum values for the metal concentrations in the ore fluid are given by the water leach data (Table 2, column 3) and that the combined metal contents of the acid and water leaches (Table 2, column 5) give maximum values. Further application of activation analysis to the study of fluid inclusions should eventually allow definite conclusions to be reached regarding the various contributions to the detected heavy metal content and may alter the tentative suggestions offered here (*9, 10*).

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9. We thank H. D. Holland of Princeton University and John W. Winchester of M.I.T. who offered constructive criticisms of the manuscript. Financial support from the Office of Naval Research at M.I.T. and the use of the U.S. Army Materials Research Agency reactor at the Watertown Arsenal, Watertown, Mass., are gratefully acknowledged. Publication authorized by the director, U.S. Geological Survey.
10. The paper by D. E. White *et al.* [*Science* **139**, 919 (1963)] provides an interesting comparison to the results presented here.
11. Analysis by C. L. Waring, U.S. Geological Survey.

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Disappearance of Luminous Designs

Abstract. *When a subject fixates on a luminous design under conditions of low illumination, he experiences a fragmenting disappearance of the figure. This fragmentation occurs in meaningful units and is comparable to the disappearance of images stabilized on the retina. The luminous paint technique offers a new and simple approach to the study of visual perception.*

When an optical image is stabilized so that eye movements do not alter its position on the retina, parts of the figure disappear and reappear rapidly (*1*). The technique for stabilizing the image (*1*) consists of a contact lens and an optical projector, which maintain the image on the same retinal spot despite normal nystagmus and voluntary eye movements of the subject. The resulting disappearance is organized and offers evidence concerning two leading positions with regard to visual perception (*2*).

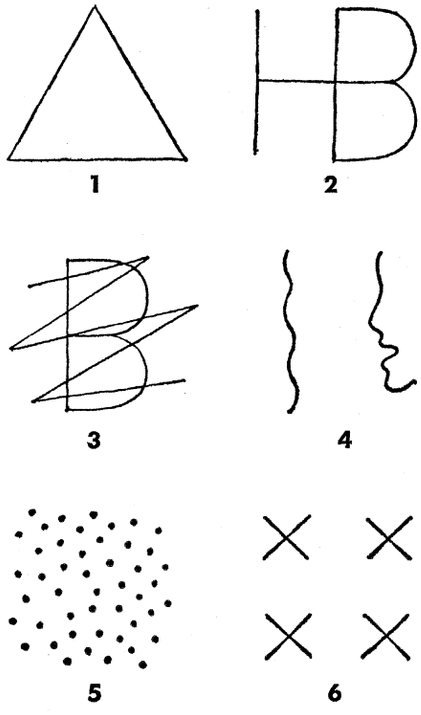
The present report describes similar phenomena, which have resulted from the use of luminous drawings under conditions of reduced illumination. The similarity first became apparent when subjects were being tested for their per-

Table 1. Fragmentation of triangle under conditions of fixation (I), eye movement around triangle (II), and eye movement from triangle to peripheral design (III).

Trials on which fragmentation was reported (%)	Mean latency of fragmentation (sec)	Subjects reporting fragmentation (%)
	Condition I	
100	4.34	100
	Condition II	
27	18.63	40
	Condition III	
0		0

ception of the vertical with the luminous rod and frame described by Witkin *et al.* (*3*). Occasionally subjects complained that the rod or discrete segments of the frame disappeared from view and reappeared again, particularly if they were "staring" at some portion of the luminous apparatus. Upon examination it was found that the phenomenon was almost universal. Earlier subjects had not reported the disappearance either because they had not fixated long enough or because they were concerned only with the problem of verticality (*4*).

Because of the similarity of these observations to the stabilized retinal image results, five designs (Figs. 1 to 5) were painted with luminous paint on dark purple construction paper.



Figs. 1–6. Designs used.

These figures, from Pritchard, Heron, and Hebb (*1*), were painted with lines 1 inch wide, on a surface area 24 by 24 inches. The figures were presented one at a time in a completely darkened room. Reflections from other surfaces were eliminated so that no other object was visible. The subjects were seated 9 feet from the drawings and, viewing each figure binocularly, were asked to report what they observed. No attempt was made to adapt the subjects to darkness beforehand. Tape recordings of subjects' observations were made. The data obtained by this technique were strikingly similar to the data on stabilized images.

The fragmentation of the figures occurred rapidly, the latency being as short as 3 seconds in some instances. Complex figures remained intact longer than simple ones. The disappearance occurred in perceptual units, not at random. Whole lines disappeared, breaking down at intersections, and often meaningful figures were the remaining result. For example, with Fig. 2, some subjects reported that they saw just the letter *H*, then the letter *B*, or the number *3* (that is, the loops of the *B*), or again the number *13*. Other observations supporting the meaningfulness of the disappearance have been noted. One subject saw the *B* floating out in front of the hatched lines in Fig. 3; and several subjects reported seeing four diagonal lines all pointing the same way in Fig. 6. In other words, meaningful perceptual units remained under these conditions as well as under the stabilized retinal image conditions.

Ten subjects were used in an experiment to test the relation between the disappearance and eye movement. Each subject viewed the triangle binocularly (Fig. 1) three times under three different conditions.

Under condition I, the subject fixated at the apex of the triangle (Fig. 1) and reported the instant any segment of it disappeared. Under condition II, the subject was instructed to move his gaze along the lines of the triangle, beginning at the apex, following the right leg to the base, then across the base and up the left leg. He was asked to repeat this sequence for 2 minutes or until a segment of the triangle disappeared. Under condition III, the subject was instructed to look at the whole triangle and then immediately shift his gaze to another smaller luminous design (Fig. 6) which was located in the periphery, 24 inches below and 24 inches to the left of the triangle. Figure 6 was painted with luminous lines, ½ inch wide, on an 8- by 8-inch surface area. The subject was again asked to report any disappearance of parts of the triangle while he was shifting his gaze from one object to the other during a 2-minute period. He was not to report any changes in the smaller peripheral figure (Fig. 6).

For the fixation condition (I), all subjects reported disappearance on all three trials, while in condition II only four of ten subjects reported fading and then not on all trials. Under condition III no subject reported disappearance on any of the three trials. These data are presented in Table 1. All differences between conditions I, II, and III are significant. These results suggest that the probability of fragmentation is greatly reduced as the freedom of voluntary eye movement and the variability of the visual field are increased.

These data parallel the stabilized image phenomenon described by Pritchard (*2*) and Pritchard, Heron, and Hebb (*1*) in studies of visual perception. Because of its simplicity, the luminous paint technique offers distinct advantages. A large number of subjects can be tested quickly and easily without special lenses or adaptation trials. A number of potential stimulus variables can be manipulated easily—the background illumination, dark adaptation, the size of retinal arc on which the figure is impinging, and the amount of light being emitted from the figure itself. The effect of the number of objects in the visual field can also be studied simply. Aside from its theoretical implications, such research may have practical application with regard to the use of instrument panels, or wherever luminous dials have been used.

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